AGRICULTURAL COLLEGE EXTENSION

UNIVERSITY OF ILLINOIS

THE FARM WATER SUPPLY

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It ought not to be necessary to attempt to prove the necessity for an abundant supply of water for the farm, and most people are convinced that the water should be pure. As many of us do not realize what pure water is, it is our purpose to explain what constitutes a *pure* water, why a pure water is needed, and how to get it.

What constitutes a pure water? The scientist will tell us that a pure water is *water* and nothing else. Pure water from his standpoint, is a difficult thing to obtain; because it will dissolve so many substances with which it comes in contact. The purest natural water is rain water. This has been evaporated from the seas, lakes, streams, and from the surface of the earth, leaving the soluble salts behind. Yet even rain water has dissolved gases from the air or has air itself in solution, and is thus not absolutely pure. The purest rain water is obtained after the first fall of rain has cleared the air. As soon as rain water touches the ground it begins to dissolve substances with which it comes in contact. Limestone, salt, and other mineral substances are dissolved in varying amounts, making the water impure from the scientific standpoint. For drinking purposes small amounts of these substances do not make the water impure, and unless present in excess are beneficial rather than harmful.

For our purpose we should ask, What constitutes an impure water? Impure drinking water contains either substances or organisms, or both, which will disturb the functions of the body and cause illness. Excess of some salts, like epsom salts or salts of lime, are injurious. More especially some organisms known as bacteria, if present in the water, will cause disease. According to the germ theory of disease, diseases like typhoid fever, malaria and cholera,

*Adapted from a lecture prepared for the Illinois Corn Growers and Stockmen's Convention, 1908, by Edward Bartow.

are caused by these germs. The cholera and typhoid germ are introduced into the system by drinking infected water. Water becomes infected from sewage and house drainage or directly from the excreta of persons who have had the disease. The excreta from *one* patient has been known to contaminate a water supply and cause an epidemic of typhoid fever to sweep an entire town. These living germs are not dissolved, but are held in suspension. They are too small to be seen by the naked eye and may be present in the clearest water. It is practically impossible to determine them directly, but a water analysis is their indirect determination.

Typhoid fever is the principal water-borne disease that we have to deal with. We cannot tell how much typhoid fever occurs on the farms of Illinois. No statistics are available. It is a fact, however, that typhoid fever is at its height in the cities after the summer vacation. One way of accounting for this is that the people of the city become infected in the country or at the seaside. This may be because their body resistance is less than that of the farmer, whose system is accustomed to the impure water. As one can become accustomed to the use of a drug until a large amount can be taken without effect, so it is undoubtedly possible to resist the typhoid fever germs. The farmer is not altogether immune. Many cases occur in his family. When the body resistance is lowered by even a light illness, they become more susceptible and contract the disease.

Milk is an excellent carrier of typhoid germs because it furnishes abundant food for their growth. It is often infected by impure water which is used in washing the milk utensils.

Precautions must be taken to keep wells on dairy farms in good condition. The health departments of Boston, New York, Chicago and Philadelphia make the general requirement that wells on dairy farms "must be free from contamination." The following from the New York City regulations are quoted:

Regulations of the Department of Health of New York City.

CREAMERY REGULATIONS.

The water used for cleaning pails, cans and other utensils must be from a public water supply, or, if drawn from a well of spring, must be approved by this department.

RULES FOR THE DAIRY. THE WATER SUPPLY.

The water used in the barn and for washing milk utensils must be free from contamination.

Resolution of March 31, 1907.

Resolved, That when typhoid fever or dysentery exists in any household of any employee of any creamery, farm or dairy, sending milk to New York City, no water from any well or spring within one hundred feet of such premises, or from any well or spring used by the household, shall be used in barns for cleaning milk utensils without the consent of the Department of Health.

I will also quote from a letter to the owner of a farm located about sixty miles from New York City, in which the statement is made, "That the privy or cesspool be located not nearer than 250 feet from the source of the water supply."

Adherence to these rules will do much to lower the typhoid fever rate.

The importance of a pure water supply on a dairy farm and also on any farm, the water from which may enter the milk supply, may be nicely illustrated by considering the rapid growth of bacteria. It has been shown that some bacteria under favorable conditions, will increase by division every eighteen minutes. This would mean that they would multiply three times in an hour, six times in two hours, etc. Starting with one bacterium, there will be two at the end of eighteen minutes, four at the end of thirty-six minutes, eight at the end of fifty-four minutes, or, say at the end of an hour. With three multiplications during the next hour, at the end of the second hour there will be sixty-four. In three hours and twenty minutes there will be 1,000. In seven hours, 1,000,000, in ten and one-half hours 1,000,000,000, and so on. We cannot ex-

pect this complete multiplication under all conditions, but even should half or one-quarter of the number grow, one can readily see what disaster may follow from a few typhoid fever germs carelessly allowed to enter a can of milk.

A large majority of the farm well waters sent to the State Water Survey for analysis, are sent because the purity of the water is suspected. It is very rare that such a sample is sent in unaccompanied by a report that there are from one to five cases of typhoid fever among the users of the water. For this reason our records give a very poor idea of the actual conditions of farm waters in the state. During 1907 the State Water Survey condemned 60 per cent of all well water analyzed, eighty-five per cent of wells condemned were less than 25 feet deep, and 77 per cent of those between 25 and 50 feet deep were condemned.

In order to have a more accurate knowledge of the condition of farm water supplies, we need to know the character of waters that are perfectly free from contamination; or, in other words, we need to determine the normal waters for each district. In order to have such an accurate knowledge, it would be necessary to make a water survey of the state, similar to the soil survey being made under the direction of Professor C. G. Hopkins. The character of the water supply varies as the soils vary, and as the rock strata vary. Since different kinds of earth and different kinds of rock are found at various depths below the surface, we may say that the character of the water also varies with the depth of the wells. Sometimes, as in the case of dug wells which are cased with brick or stone, the water may enter the wells from various levels; and while a good water might be obtained from the lowest level, there is a possibility of its becoming contaminated by water entering from near the surface or by the water itself washing back into the depths of the well through the curb carrying with it pollution from the surface.

The usefulness of germ free waters for farm water supplies varies with the hardness. A hard water contains salts of calcium and magnesium. These salts, when present in water in which meat or vegetables are cooked, form insoluble albuminates. Tea and

coffee are not as good when made with hard water. A hard water is also not economical, requiring a larger amount of soap than does a soft water. It causes a scale on the vessels in which it is used, and it is unpleasant for general lavatory and laundry uses. It has been calculated that $180,000 was saved annually by the city of Glasgow by changing from a hard water to the soft Loch Katrine water. In many cases it is possible to use a soft cistern water, and this, when collected on the clean roofs of farm houses, is quite satisfactory. When, however, the cistern water is not available, the hard well water may be easily softened by using chemicals. The most suitable are lime and soda. The lime is used in the form of a saturated solution, the soda as one part dissolved in ten parts of water. The lime removes temporary hardness, that is, hardness caused by the presence of carbonates which is mostly removed by boiling. The soda is for the permanent hardness caused by sulphates, chlorides and nitrates of calcium and magnesium, which are not removed by boiling. The lime water is prepared by slacking lime and dissolving the slacked lime in water, or, better, by dissolving hydrated lime in water. A pail of lime water added to from three to ten pails of hard water in a barrel, according to the hardness of the water, will cause the formation of a precipitate which will soon settle, leaving a comparatively soft water suitable for domestic use. It must be noted that the lime does not remain in the water but comes out in the precipitate. In some cases it is necessary to add a little soda. When it is considered that one pound of lime will do the work of fifty pounds of soap, the economy of the practice can easily be seen. On well waters in Illinois, it is safe to use one part of lime water to ten; more should often be used, but this should not be done without preliminary tests. An example of the amount to use is seen in the table of "Hardness of Municipal Water Supplies."* All the soap used before a lather forms is absolutely wasted; then, too, when hard water is used in washing cloth, a precipitate of lime soap or curd collects in the cloth and is difficult to wash out.

In order to obtain some definite knowledge of the conditions of a few farm water supplies, we have, during December, 1907, and

* Univ. of Ill. Bul. Water Survey Series No. 7, p. 100.

January, 1908, collected five series of ten samples each, from farms in different parts of the state. An endeavor has been made to obtain waters from wells in places where the conditions differ and which are typical of large sections of territory. Other conditions undoubtedly exist and we wish it might have been possible to obtain specific samples from every county in the state. Some times conditions may vary even in the same county. The collections have been made northwest of Champaign, in Champaign county, from near Centralia, in Marion county; from east of Elgin, most of the samples having been taken from Cook county; from northwest of Kankakee, in Kankakee county, and from north of Cairo, in Alexander county. These points were chosen because widely separated and also because of the differences in sources of supply.

The source and characteristics of the water used at these places on the farms follow:

CAIRO.

A series of ten samples was collected on January 20, 1908, from farms north of Cairo, in Alexander county. The water supply of these farms was quite varied in character. The ten samples included three cisterns, three shallow driven wells, with pitcher pumps; three deeper driven wells, and one deep drilled well, which was free flowing.

No. 1. (17004) is a driven well 35 feet deep. Both chemically and bacterially it was shown to be in good condition.

No. 2. (17005) is from a cistern located at same place as No. 1. The surroundings were poor and the casing was open. The analysis indicates the possibility of leakage, shown by the alkalinity and the high residue on evaporation. The consumed oxygen, albuminoid ammonia, and nitrogen as nitrites indicate the presence of organic matters. The number of bacteria was not excessive, but the chemical examination indicated the probability of rapid growth should any infection enter. This cistern water was preferred to the well water for drinking by the people living in the house. In our opinion the cistern at this time was not in satisfactory condition, not having been cleaned for about fifteen months.

No. 3. (17006) is from a 60-foot drilled well. The water-bearing

strata, however, is from 40 to 45 feet deep. The analysis showed results comparable with No. 17004, but the water which was clear when first drawn, became turbid on standing and had an odor of hydrogen sulphide. The water is safe for use for drinking purposes, though the turbidity and odor would render it unattractive. The residents preferred the cistern water obtained from a cistern reported as No. 4.

No. 4. (17007) is from a cistern which, while well curbed, had no covering. It showed evidence of organic matter and a bacterial examination was unfavorable. The well water in this case is preferable to the cistern water.

No. 5. (17008) is a driven well 50 feet deep. The surroundings were not good, yet the chemical examination was quite favorable. From a bacterial standpoint the water was only fair. The unfavorable bacterial condition was probably due to defective casing.

No. 6. (17009) is a 60-foot driven well located at the tri-city park close to the highway. This water shows high chlorine and nitrates, indicating that surface water from the neighborhood is the source of its supply. The low consumed oxygen, free and albuminoid ammonia, and the favorable bacterial examination indicate that the water is satisfactorily filtered before entering the water-bearing strata and is safe for drinking purposes.

No. 7. (17010) is a driven well to which a pitcher pump was attached. This water, while clear when first drawn, became very turbid on standing. Aside from the turbidity, the water is excellent for drinking purposes. The people at the house preferred to use cistern water.

No. 8. (17011) is a well near to and similar in character to No. 7, and aside from its turbidity it is in good condition for drinking purposes. The people in the house use this water for drinking purposes.

No. 9. (17012) is from an artesian well about 800 to 900 feet deep. The water was shown to be excellent, though it has a slight odor of hydrogen sulphide. This water is piped to the farm houses, and is used there.

No. 10. (17013) is a cistern water which was well cared for. The surroundings are excellent and the water is filtered. The filtration, however, would not entirely remove turbidity and color. The consumed oxygen is high. Bacterially the number of bacteria per cubic centimeter is large, though no positive tests for intestinal bacteria were found.

Our conclusions concerning the ten waters taken from near Cairo are that it is possible to obtain a satisfactory water from driven wells about 40 feet deep, although there is a possibility of finding water containing iron, which causes turbidity on exposure to the air. This leads many of the people to prefer cistern water. The cisterns are usually neglected and the water is frequently foul either from washings from the roofs or because of leakages, or from unsatisfactory curbings. The deep artesian well water similar in character to the deep well water obtained at Cairo, would give the more satisfactory water. There is a possibility for several farmers to join together to drill a deep well. They can then have the water piped to their respective farms. The expense of drilling such a well is usually greater than one farmer would care to stand.

CENTRALIA.

A series of ten samples was collected on January 7, 1908, from farms near Centralia:

No. 1. (16888) is from a 30-foot dug well, Sec. 13, T. 1 N., R. 1 E. The well was about 100 feet from the privy, 150 feet from the stable, 50 feet from the feed lot, 10 feet from dumping ground for slops, dish water and wash water. There had been one case of typhoid fever about two years before. Both the chemical and bacterial examination indicated pollution.

No. 2. (16889) is an 18-foot dug well near No. 1. It is about 30 feet from the stable and is used for stock only. Both the chemical and bacteriological data indicate pollution.

No. 3. (16890) is a 24-foot dug well in Brookside township, T. 1, R. 1. The well was dug in clay and cased with brick. All the chemical and bacteriological data would indicate contamination.

SAMPLES FROM CAIRO, ILLINOIS. COLLECTED JANUARY 20, 1908.

Laboratory No.	Appearance. Turbidity.	Appearance. Color.	Appearance. Odor.	Total Solids.	Chlorine.	Oxygen Consumed.	Nitrogen as Ammonia. Free.	Nitrogen as Ammonia. Albuminoid.	Nitrogen as Nitrites.	Nitrogen as Nitrates.	Alkalinity.	Bacteria per c. c.	Colon Bacillus. 10 c. c.	Colon Bacillus. 1.0 c. c.	Colon Bacillus. 0.1 c. c.	Indol.	Depth.	Remarks.
17004	0	0	0	505	3	1.3	.038	.084	.050	1.03	466	260	1—	2—	2—	+	35′ driven	good
17005	0	.4	0	172	3	7.5	.004	.102	.250	.35	86	180	1?	1+ 1?	2—	—	Cistern	poor
17006	130	.1	H S	540	3	2.7	.280	.040	.006	.074	512	380	1—	2—	2—	—	60′ drilled	good
17007	20.	.8	0	79	4	3.5	.146	.190	.200	.400	36	300	1—	1— 1+	2+	+	Cistern S.	poor
17008	0	0	0	345	4	1.7	.000	.024	.015	1.905	306	120	1?	1? 1+	2—	+	50′ driven	fair
17009	0	0	0	436	15	1.4	.000	.056	.010	6.390	306	420	1—	2—	2—	+	60′ driven	poor
17010	170	0	0	530	7	2.1	.084	.056	.000	.000	434	210	1—	2—	2—	—	30′ driven	fair
17011	110	0	0	440	7	2.5	.854	.060	.002	.558	378	580	1—	2—	2—	—	20′ driven	fair
17012	5.	.4	H_2S	339	97	1.3	.160	.000	.000	.200	140	8	1—	2—	2—	—	*800′ to 900′	good
17013	10.	.5	0	85	3	4.7	.052	.092	.000	.760	58	1300	1?	2?	2—	+	Cistern	fair

*Drilled.

SAMPLES FROM CENTRALIA, ILLINOIS, COLLECTED DECEMBER 24, 1907.

Laboratory No.	Turbidity.	Color.	Odor.	Total Solids.	Chlorine.	Oxygen Consumed.	Free.	Albuminoid.	Nitrites.	Nitrates.	Alkalinity.	Bacteria per c. c.	10 c. c.	1.0 c. c.	0.1 c. c.	Indol.	Depth.	Remarks.
16888	0	0	0	1379	240	3.2	.016	.108	.001	22.0	440	800	1—	1+ 1—	2—	+	30	bad
16889	0	0	0	461	29	1.6	.052	.056	.000	8.6	310	1200	1?	2+	1+ 1—	+	15	"
16890	0	0	0	765	134	2.5	.008	.048	.000	5.12	412	650	1+	2+	2+	+	24	"
16891	0	0	0	1629	122	4.8	.008	.078	.000	41.0	488	Lost	1+	1+ 1—	2—	+	24	"
16892	0	0	0	441	8	1.5	.004	.028	.001	.72	364	400	1?	2—	2—	+	15	good
16893	0	0	0	1805	200	3.0	.008	.048	.001	60.00	484	16000	1+	2+	2+	+	36	bad
16894	10	0	Musty	1205	118	4.0	.020	.096	.022	31.98	370	20000	1—	1+ 1—	2+	+	30	"
16895	0	0	0	1546	57	2.4	.050	.114	.000	12.00	370	400	1—	2+	1? 1—	+	35	"
16896	0	0	0	2640	380	4.0	.058	.096	.000	32.00	378	1500	1—	1? 1—	2—	+	35	"
16897	0	0	0	1996	66	3.5	.030	.090	.050	51.95	436	4600	1—	1+ 1—	1+ 1—	+	25	"

No. 4. (16891) is a 24-foot dug well near No. 3. All the data indicated surface contamination.

No. 5. (16892) is a 15-foot dug well, 50 feet from privy, 30 feet from stable, 10 feet from feed lot, and 50 feet from a pig pen. Both the chemical and bacteriological examinations indicated a satisfactory water.

No. 6. (16893) is a 36-foot dug well in Sec. 11, T. 1, R. 1, 75 feet from privy, 100 feet from stable, and 50 feet from feed lot. All the chemical and bacteriological data indicated contamination.

No. 7. (16894) is a 30-foot dug well in Sec. 11, T. 1, R. 1, 50 feet from stable and 10 feet from feed lot, practically located in a barn yard. All the data indicated that this water was unsatisfactory for drinking purposes.

No. 8. (16895) is a 35-foot dug well in Sec. 11, T. 1, R. 1, 50 feet from privy, and 50 feet from feed lot. The well was cased with brick. All the data would indicate contamination.

No. 9. (16896) is a 35-foot dug well, 100 feet from privy, 50 feet from stable, 50 feet from feed lot, and 50 feet from dumping grounds for dish water. All the data indieated that this water was polluted by surface water.

No. 10. (16897) is a 25-foot dug well in Sec. 11, R. 1, T. 1, 100 feet from privy, 40 feet from stable, and 30 feet from feed lot. The curbing in this case is poor. All the analytical data indicated pollution.

The table gives a summary of the results obtained in analyzing waters from Centralia.

An inspection of the data concerning ten wells at Centralia shows that nine are evidently polluted, and yet in only one case was a report given of typhoid fever among the users of the water.

CHAMPAIGN.

A series of ten samples was collected on December 19, 1907, from farms northwest of Champaign:

No. 1. (16873) is a 160-foot drilled well, in Sec. 2, T. 19 N., R. 8 E. This well is located in a barn yard, 60 feet from a privy, 160 feet from a cesspool, 75 feet from a stable. The anaytical results

showed it to be a water similar in composition to that furnished by the Champaign and Urbana Water Company. It becomes turbid, due to the presence of soluble iron salts, which become insoluble on exposure to the air, causing not only the turbidity, but also giving a color. From a bacteriological standpoint this water was excellent. The turbidity or cloudiness would make it less attractive as a drinking water than the polluted water in a dug well close by, an account of which is seen under No. 2.

No. 2. (16874) is 25 feet deep, in Sec. 2, T. 19 N., R. 8 E.; is cased with tile and had at that time a covering which was faulty. It is located practically in the barn yard, 60 feet from the privy, 150 feet from the cesspool and 60 feet from the stable. From a physical standpoint the water was clear and colorless and had no odor. The chemical examination, however, showed that it evidently contained considerable quantities of the surface drainage. It also contained an excessive number of bacteria. Such a water should not be used for drinking purposes, though from outward appearances a more attractive water than the water from the deep well near by.

No. 3. (16873) is a 16-foot dug well, and is located in Sec. 2, T. 19 N., R. 8 E, and is located 100 feet from privy, 10 feet from the stable and is practically in a barn yard. The chemical analysis showed that this water contained surface drainage. From a bacteriological standpoint it was in fair condition, but we would suggest that such water be boiled before using it for drinking purposes.

No. 4. (16876) is a 65-foot bored well, Sec. 35, T. 20 N., R. 8 E., and is cased with cypress, with curbing in poor condition. The well is located in a feed lot about 50 feet from the stable. Physically the water appeared to be good, chemically, poor; bacteriologically poor. This water was only used for stock and should not be used for drinking purposes.

No. 5. (16877) is a 180-foot bored well, and is located in Sec. 35, T. 20 N., R. 8 E., 50 feet from privy, 30 feet from cesspool. The water was similar in character to the Champaign and Urbana supply and was excellent from a sanitary standpoint.

No. 6. (16878) is a 28-foot dug well in Sec. 34, T. 20 N., R. 8 E. Privies and cesspools do not seem to be more than 100 feet distant. It is located near the house in apparently excellent conditions. Physically it was a bright, clear water, chemically it showed evidences of having been collected on inhabited areas. From a bacteriological standpoint it was good. This water is apparently safe for drinking purposes, but contains a higher residue than is desirable and is less suitable for household use than the water from the deep well near by, which is described under the next number.

No. 7. (16879) is a 190-foot bored well located in Sec. 34, T. 20 N., R. 8 E. This water showed results similar to the deep wells of the county and is very satisfactory for drinking purposes.

No. 8. (16880) is a 170-foot drilled well in Sec. 3, T. 9 N., R. 8 E. This water shows the characteristics of a deep well of the section and is an excellent water for domestic uses. The water from this well was pumped to the tank by a gasoline engine located in the basement of the house.

No. 9. (16881) is a 28-foot dug well in Sec. 2, T. 19 N., R. 8 E. It is 50 feet from the stable. No other objectionable features seemed to be within 100 feet, but there was apparently a chance for surface water to enter through the curbing. The chemical analysis showed evidences of pollution.

No. 10. (16882) is a 160-foot driven well in Sec. 2, T. 19 N., R. 8 E., and while it is practically in the barn yard, near the privy and stable, with a dumping ground for slops near by, it had no evidences of any contamination.

An inspection of these analyses shows that the deep well waters were in excellent condition. According to the chemical analysis all of the shallow wells showed pollution. One gave a very favorable bacterial examination and may be considered good. The deep well waters contain less residue and are softer than the shallow well waters. The results of our examinations would indicate that it is advisable for the farmers in the neighborhood of Champaign to use the waters from the deep driven wells in preference to the shallow wells.

SAMPLES FROM CHAMPAIGN COUNTY, ILLINOIS, COLLECTED DECEMBER 19, 1907.

Laboratory No.	Appearance.			Total solids	Chlorine	Oxygen consumed.	Nitrogen as				Alkalinity.	Bacteria per c. c.	Colon Bacillus.			Indol.	Depth.	Remarks.
							Ammonia.											
	Turbidity	Color	Odor				Free.	Albuminoid.	Nitrites	Nitrates			10 c. c.	1.0 c. c.	0.1 c. c.			
16873	10.	.2	0	377	3	7.6	.720	.144	.000	.16	346.	160	1—	2—	2—	—	160	Good
16874	0	0	0	1662	180	4.0	.024	.136	.020	50.00	360.	650	1—	2—	1—	+	25	Bad
															1?			
16875	0	0	0	510	30	2.3	.016	.064	.008	12.00	244.	250	1—	2—	1—	+	16	Bad
															1+			
16876	5.	0	0	567	37	2.8	.116	.080	.006	4.8	358.	1500	1—	2+	2—	+	65	Bad
16877	0	.4	0	513	3	8.6	2.800	.160	.000	.08	462.	40	1—	2—	2—	—	180	Good
16878	0	0	0	948	132	2.3	.024	.056	.000	3.04	350.	100	1—	2—	2—	—	28	Good
16879	0	.4	0	512	3	9.5	4.800	.224	.000	.08	496.	10	1—	2—	2—	—	190	Good
16880	0	.2	0	358	3	5.0	1.280	.096	.000	.08	340.	0	1—	2—	2—	—	170	Good
16881	0	0	0	463	20	1.8	.176	.070	.007	2.00	338.	10	1—	1—	1+		28	Bad
														1+	1—			
16882	0	.2	0	345	2	3.5	.640	.128	.000	.08	324.	10	1—	2—	2—	—	160	Good

SAMPLES FROM ELGIN, ILLINOIS, COLLECTED JANUARY 3, 1908.

Laboratory No.	Turbidity	Color	Odor	Total solids	Chlorine	Oxygen consumed.	Free.	Albuminoid.	Nitrites	Nitrates	Alkalinity.	Bacteria per c. c.	10 c. c.	1.0 c. c.	0.1 c. c.	Indol.	Depth.	Remarks.
16921	0	0	0	298	6	.6	.076	.058	.000	2.00	210	90	1—	2—	2—	—	35 dug	Good
16922	10.	.3	0	398	3	4.3	1.60	.160	.000	.08	378	30	1—	2—	2—	—	313 drilled	"
16923	0	0	0	752	32	1.7	.008	.072	.000	3.60	548	Lost	1—	2—	2—	—	27 dug	"
16924	5.	.8	0	472	2	9.2	1.75	.240	.000	.000	438	26	1—	2—	2—	—	204 drilled	"
16925	5.	.1	0	249	3	1.9	.752	.024	.000	.000	216	21	1—	2—	2—	—	175 drilled	"
16926	0	0	0	973	200	2.0	.032	.152	.002	8.00	388	600	1?	1+	1—	—	27 drilled	Bad
														1—	1+			
16927	0	0	0	827	24	1.7	.056	.056	.000	.88	430	160	1—	2—	2—	—	40 dug & driven	Good
16928	0	0	0	492	36	3.2	.024	.104	.050	1.95	296	200	1—	2—	2—	+	197 bored & "	"
16929	10.	0	0	325	3	11.3	.608	.032	.000	.000	324	80	1—	2—	2—	—	165 drilled	"
16930	0	0	0	350	6	1.0	.016	.044	.000	.000	324	600	1+	2—	2—	+	25 dug	"

ELGIN.

A series of ten samples was collected on January 3, 1908, from farms near Elgin; most of them were in Hanover township, Cook county:

No. 1. (16921) is a dug and bored well 35 feet deep. The only source of contamination found was a chicken house 50 feet away, and a stable 200 feet away. One case of typhoid fever was reported six years ago. The analysis showed favorable results except in the free and albuminoid ammonia, and perfect satisfaction would undoubtedly be given if all the water were shut out from the dug part of the well.

No. 2. (16922) is from a drilled well 331 feet deep, and while it is near a stable it was shown to be excellent in every particular.

No. 3. (16923) is from a dug well 27 feet deep. The chemical analysis indicates that surface water enters the well. The absence of intestinal bacteria was shown. This water was used only for watering stock, and it would be advisable not to use it for drinking purposes.

No. 4. (16924) is a drilled well 204 feet deep. The water was excellent in every particular.

No. 5. (16925) is a drilled well 175 feet deep. The water was shown to be excellent in every particular.

No. 6. (16926) is a drilled well 27 feet deep, and showed evidence of contamination, both chemically and bacterially. The surroundings were poor, a privy being 50 feet away, cesspool 10 feet away, a stable 100 feet away, and a dumping ground for slops about 20 feet away. Such water should not be used for drinking purposes.

No. 7. (16927) is a 40-foot driven well with an iron casing extending from top to bottom. Bacterially the water was excellent. Chemically it was also good. This is an illustration of the advantage of a driven well over a dug well.

No. 8. (16928) is a driven well 197 feet deep, with very favorable surroundings. Bacterially the water was in excellent condition. Chemically there was evidence of entering surface water, and while not first class, was probably in good condition at the time of the analysis.

No. 9. (16929) is a drilled well 165 feet deep. The high consumed oxygen is rather surprising, otherwise the water shows the characteristics of deep wells and was evidently perfectly safe for use for drinking purposes.

No. 10. (16920) is a 20-foot dug well, the surroundings are not very favorable, a privy being located 10 feet away, a cesspool 10 feet, a stable 100 feet, dumping ground for slops, dish water, etc., 10 feet. The chemical examination showed the water to be in excellent condition. The bacterial results showed it to be only fair. The water was probably safe, but liable to surface contamination at any time.

The deep rock wells in the Elgin district furnish an excellent water supply for household purposes. The shallow wells, especially the dug wells, are much less desirable; the one shallow driven well was shown to be good, proving the greater desirability of this class of well over the shallow dug well.

KANKAKEE.

Ten samples were collected on January 13 from farms northeast of Kankakee, in Bourbonnais township, Kankakee county:

No. 1. (16962) is from a 45-foot well drilled in limestone. This well is about 50 feet from a privy, 100 feet from a stable and 20 feet from the barn yard. Chemically there was evidence of entering surface water. The tests for bacteria showed that the water was in excellent condition.

No. 2. (16963) is from a 60-foot well drilled in limestone. The well is located 30 feet from a privy, 100 feet from a stable, feed lot and dumping grounds for slops. There had been a case of typhoid fever last September. Chemically this water showed evidence that the water had been collected on polluted surfaces. From a bacterial standpoint the results were excellent. We can regard this as only fair water for drinking purposes.

No. 3. (16964) is from a 45-foot well drilled in limestone, 100 feet from a privy, 200 feet from feed lot, and 300 feet from stable. All the analytical data indicated that this water was in first class condition.

No. 4. (16965) is a 40-foot well drilled in limestone, 300 feet from a privy, 100 feet from a stable, and 10 feet from feed lot. While this water was used for stock only, it was shown to be in excellent condition for general drinking purposes.

No. 5. (16966) is a 45-foot well drilled in limestone. This well was 40 feet from a privy, 30 feet from a stable, and 50 feet from feed lot. It was shown to be in excellent condition for drinking purposes.

No. 6. (16967) is a 12-foot driven well, located in a barn yard, 20 feet from a stable. Chemically there was evidence of gross contamination. From a bacterial standpoint this water was shown to be good. The organic matter was so high above the average that we believe it ought not to be used for drinking purposes.

No. 7. (16968) is a 37-foot well dug and drilled in limestone, 120 feet from a privy, 75 feet from stable, 20 feet from feed lot. Two cases of typhoid fever were reported in August, 1907. While the bacterial results at this time were shown to be good, the chemical examination showed evidence of gross pollution. The residue on evaporation was excessive, and such a water should not be used for drinking purposes.

No. 8. (16969) is a 100-foot drilled well. Bacterially the water was shown to be only fair. From a chemical standpoint there was evidence of surface pollution, and either the data given us was wrong or surface water enters the well.

No. 9. (16970) is a 104-foot drilled well. All the data, both chemical and bacteriological, indicated a satisfactory water for drinking purposes. The water being very different in character from No. 8, may be regarded as a normal water for a well 100 feet deep.

No. 10. (16971) is a 50-foot dug well, reported dug in clay. The bacteriological examination showed it to be a good water. The chemical examination indicated the entering of surface water. The residue on evaporation is excessive, rendering it only a fair water for domestic use.

Considering the ten samples from Kankakee the drilled rock wells from 40 to 50 feet deep are the most satisfactory. The nor-

SAMPLES FROM KANKAKEE ILLINOIS. COLLECTED JANUARY 13, 1908.

Serial No.	Appearance.			Total Solids.	Chlorine.	Oxygen Consumed.	Nitrogen as				Alkalinity.	Bacteria per c. c.	Colon Bacillus.			Indol.	Depth.	Remarks.
							Ammonia.											
	Turbidity.	Color.	Odor.				Free.	Albuminoid.	Nitrites.	Nitrates.			10 c. c.	1 c. c.	0.1 c. c.			
16962	0	0	0	488	20	.9	.036	.060	.002	7.60	274	120	1—	2—	2—	—	45′ drilled	good
16963	0	0	0	826	44	1.3	.036	.062	.004	29.6	308	90	1—	2—	2—	—	60′ drilled	fair
16964	0	0	0	231	5	.9	.054	.060	.000	.28	184	20	1—	2—	2—	—	45′ drilled	good
16965	0	0	0	263	9	1.0	.016	.036	.000	.20	172	120	1—	2—	2—	—	40′ drilled	good
16966	20.	0	0	254	3	1.3	.042	.024	.002	.28	164	160	1—	2—	2—	—	45′ drilled	good
16967	0	0	0	830	90	2.0	.040	.122	.300	17.57	234	40	1—	2—	2—	—	12′ driven	poor
16968	0	0	0	1750	290	1.5	.036	.092	.003	68.00	364	200	1—	2—	2—	—	37′ dug & drvn.	bad
16969	30	0	0	1117	126	3.3	.014	.118	.002	18.00	316	600	1—	2—	2—	+	100′ drilled	poor
16970	5.	0	0	403	7	1.8	.450	.074	.004	.48	374	44	1—	2—	2—	—	104′ drilled	good
16971	0	0	0	1016	98	2.7	.010	.116	.000	36.00	246	230	1—	1— 1+	2—	—	50′ dug	fair

mal residue on evaporation is less than 400., normal chlorine 10., normal nitrates 0.3. An excess over these figures would indicate surface contamination.

GENERAL CONCLUSIONS.

In those parts of the state where it is possible to obtain a satisfactory water by means of driven or bored wells, such wells are much to be preferred to the dug wells. This may be easily illustrated by a little drawing. (See Fig. 1.). In a dug well the casing

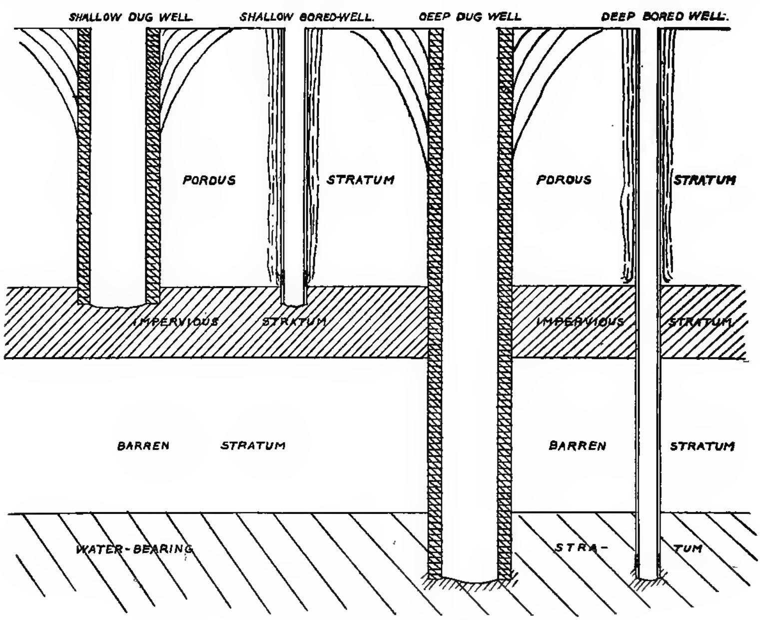

Fig. 1. Driven Wells safer than Dug Wells.

is either stone or brick, or, as in one well which I noticed, tile. Such a casing allows water to seep in through its entire depth. We all know how water will flow through the sides of a hole from top to bottom, the hole draining the earth for some distance. A similar state of affairs will be noticed with dug wells. Water flowing on the surface will carry with it any dirt or filth which may be near. In the case of the drilled, driven or bored wells, carefully cased, there is no chance for water to enter the well above the strainer.

All water which enters such a well must therefore pass through a layer of earth of a thickness equal to the distance from the surface to the top of the strainer, the earth thus serving as a natural filter. Comparative tests of dug wells and driven wells show that the driven wells are frequently free from bacteria, though often carrying large quantities of soluble substances like salt and nitrogenous compounds, indicating thus the polluted origin of the water, but showing how the water has been filtered by passing through the earth.

In some cases the drilled, driven or bored well, passes through a layer of earth through which water will not pass, and therefore the water supply must come from a considerable distance and will have a chance to become thoroughly purified during its passage through the earth. For this reason the deeper wells throughout the state, some of which have been analyzed in our series of farm well waters, are shown to be free from bacteria.

We realize that in some sections of the state, possibly at Centralia, it is not practical to obtain water from either the driven, drilled or bored wells, because the deep drilled wells are salty, and the shallower wells enter a stratum of earth of such a character that there is not sufficient flow through the small opening of the strainer. In the latter cases the dug well is needed to give reservoir capacity, so that the water may accumulate between pumpings. In such cases we would suggest that a special reinforcement of the casing be used.

Our suggestion is that the earth be excavated for four feet outside of the regular casing, that a coating of water-proofed Portland cement be placed over this casing (See Fig. 2), and that the bottom of this excavation, which should be at least four feet deep, be covered with several inches of water-proofed Portland cement, having a raised portion at the outer edge. (See Fig. 2). This will serve to divert the surface water away from the well, and it

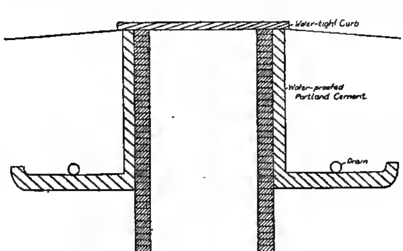

Fig. 2. Protection for Dug Wells.

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